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Sustainability standards in global agrifood supply chains

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Agrifood supply chains contribute to many environmental and social problems. Sustainability standards—rules that supply chain actors may follow to demonstrate their commitment to social equity and/or environmental protection—aim to mitigate such problems. We provide a narrative review of the effects of many distinct sustainability standards on different supply chain actors spanning multiple crops. Furthermore, we discuss five emerging questions—causality, exclusion, compliance and monitoring, excess supply and emerging country markets—and identify directions for future research. We find that, while sustainability standards can help improve the sustainability of production processes in certain situations, they are insufficient to ensure food system sustainability at scale, nor do they advance equity objectives in agrifood supply chains.

The agrifood sector faces pressing environmental challenges, including climate change, deforestation and biodiversity loss[1]. Similarly, social problems, including malnutrition, working poverty, child labour and poor labour conditions, plague the agrifood sector, which employs a large share of the world's most vulnerable populations[2]. Private standards and certification schemes focused on sustainability—including Fairtrade, organic and Rainforest Alliance—are intended to mitigate social and/or environmental problems by addressing externalities arising from production processes[3]. For example, sustainability standards ban farmers' use of dangerous pesticides and prohibit child labour and deforestation. Supplier adoption of sustainability standards is generally voluntary, with compliance verified through certification and regular monitoring. The added costs of certification are covered by higher prices consumers pay for certified products, often supplemented by subsidies from other supply chain actors[4,5].

The broader economic, social and environmental effects of sustainability standards are highly policy relevant, given their rising prominence in (especially higher-income) food markets; their prevalence and spread affects increasing numbers of farmers, consumers and other supply chain actors[6,7]. Consumer demand for certified products has increased in recent decades, mirroring a rise in public concerns about social and environmental problems along agrifood supply chains. Sustainability standards have also emerged as a central part of corporate social responsibility and product differentiation strategies[8,9]. In addition, the involvement of large manufacturers, retailers and food service companies (for example, coffee shops and restaurants) has further fuelled consumer demand[10]. Governments and non-governmental organizations (NGOs) have also promoted the supply and demand of certified products and the proliferation of standards[11].

Sustainability standards have received substantial scientific attention from a range of disciplines. One strand of literature draws on value chain and commodity network analysis, examining the actors, processes and power dynamics in the development, implementation and proliferation of standards[5,12–14]. Another strand focuses on whether standards deliver on their promise to benefit disadvantaged farmers and the environment[11,15–17]. Finally, various studies have looked at consumers' motives and willingness to pay for certified products[18–20]. Although a few review papers also exist, most focus on the effects of standards on farmers[11,16,21], often with an emphasis on specific standards[22,23], crops[21], or outcome variables[11,24,25].

Our contribution is twofold. First, we provide a brief, narrative review of the evidence on the proliferation, economics and impacts of sustainability standards, considering various supply chain actors (consumers, farmers, workers, business and development actors). We focus on land-based agricultural production and post-farmgate food processing, thus largely excluding the forest, fishery and garment industries, as these other sectors and their certification programmes can differ in important ways from the first two[26,27]. Most studies in our Review focus on coffee and cocoa, the two most widely certified crops globally as we show below.

Second, we address five emerging questions that have been controversial or overlooked; these emerging questions are fruitful directions for future research. Has the literature really captured the causal effect of standards on a range of supply chain actors? Are poor farmers excluded? How can compliance be enforced? Is supply of certified products currently exceeding demand? Should we expect continued proliferation of standards as food market demand growth increasingly shifts to emerging countries?

Sustainability standards in agrifood supply chains

Hundreds of sustainability standards exist[7]. We review some of the most prominent in Supplementary Table 1. Here we summarize common features of standards. We characterize several dimensions of their current proliferation and identify and describe relevant actors in certified supply chains.

Standards' limited coverage. Of the approximately 4.8 billion hectares of agricultural land in the world today (2018)[28], only

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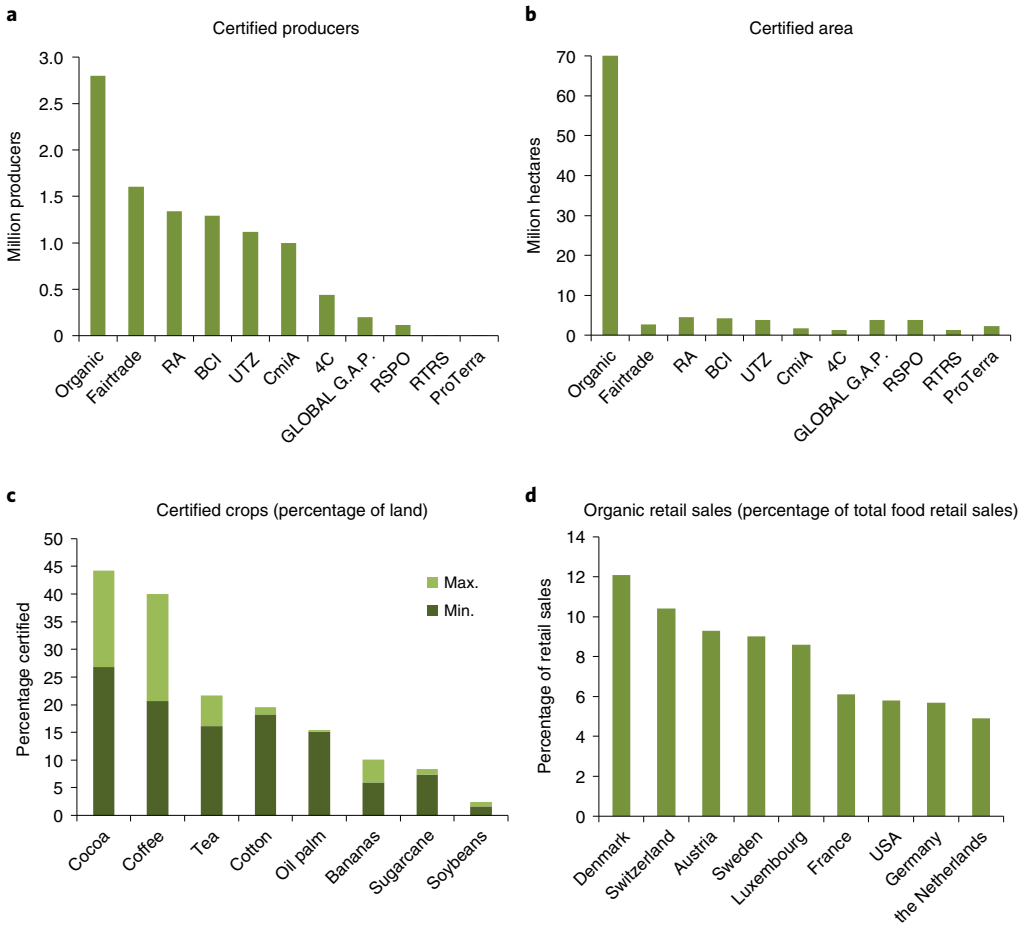

Fig. 1 | Proliferation of sustainability standards. a, Certified producers. **b**, Certified area. **c**, Certified crops. **d**, Organic retail sales. **a**–**c** are based on 2018 data[7] and **d** on 2019 data[100]. RA, Rainforest Alliance; BCI, Better Cotton Initiative; CmiA, Cotton Made in Africa; RSPO, Roundtable on Sustainable Palm Oil; RTRS, Round Table on Responsible Soy (Supplementary Table 1). Exact figures (**c**) are difficult to estimate, given the large number of standards, the prevalence of certification under multiple standards and the lack of data on multiple-certified land or producers. Minimum values[7] consider only the area certified under the single most important standard by area. Maximum values[7] sum the areas certified under the most important standards (Supplementary Table 1) but cannot account for multiple-certified farms. Thus, maximum values probably overestimate and minimum values understate the true values.

around 80 million hectares—less than 2%—are certified[7] (Fig. 1a). Nearly ten million farmers cultivate certified land, most of them in low-income countries (about 2% of small-scale farmers in low-income countries)[7]. These ten million farmers probably employ an equally large number of wage workers, sharecroppers and other subcontractors[29]. Despite the small share of total land and farmers engaged in certification, sustainability standards are very important for some commodities, such as cocoa and coffee (Fig. 1c).

Standard-setting organizations. Sustainability standards are defined by standard-setting organizations, which include NGOs (for example, Fairtrade International)[30], the private sector (for example, GlobalGAP), governments (for example, European Union or United States Department of Agriculture organic standards)[22,30,31] and multi-stakeholder initiatives (for example, Roundtable on Sustainable Palm Oil)[32,33]. Although these organizations often seek to involve diverse actors—including farmers and workers—when setting standards, the processes and outcomes tend to be dominated by, and reflect the interests of, multinational businesses, NGOs and international experts[33–36].

The different standards typically cover similar issues (for example, environment and labour conditions) and have converged over time[5], but they vary in their particular focus and stringency (Supplementary Table 1). Most standards (excluding Fairtrade) do not specify farmer output prices, as a higher price (that is, a price premium) is assumed to be a natural market outcome and only one among various benefits to farmers.

Although many standards rhetorically emphasize smallholder farmers, all standards—including Fairtrade[37,38]—can be adopted by both smallholder organizations and companies/plantations. Many standards focus on farmers (for example, Better Cotton Initiative), while others (for example, Fairtrade) also specify relations between buyers and sellers as well as post-farmgate practices. Compliance with standards is verified though certification and monitored using self-reporting, internal controls and audits by independent certification agencies[39].

Farmers. Farmers incur fixed costs (for example, protective gear for pesticide application) and variable costs (for example, hired labour) to attain and maintain certification[3,40]. Many smallholder farmers cannot meet certification requirements without financial and/or technical assistance and group-based certification. The latter reduces the logistical costs certification agencies face and farmers' costs[41,42]. For example, farmer organizations often provide training, credit and inputs. Thus, many certification-related costs (for example, higher-skilled employees[43]) are borne by farmer organizations, which often receive financial support from development agencies

or buyers[44]. For larger farms, especially in higher-income countries, individual farm-level certification is most common.

Governmental actors. Governments have played a key role in promoting sustainability standards. In low-income countries, (government-funded) development agencies often provide financial or technical support to certified farmers[11,22]. Governments have also funded multi-stakeholder initiatives to set standards, such as the Better Cotton Initiative, supported by USAID (USA); GIZ (Germany); Danida (Denmark); Sida (Sweden); and SDC (Switzerland). In higher-income countries, governments have provided direct support to (organic) farmers and consumer awareness campaigns and indirect support through public procurement of certified products[5]. Public mandatory standards are often the minimum criteria for voluntary sustainability standards (for example, national minimum wages)[5].

NGOs. Like development agencies, NGOs promote certified product supply (for example, by supporting farmers to gain and sustain certification) and demand (for example, awareness campaigns). NGOs are often involved in standard setting. By increasing public awareness, NGOs have played a key role in increasing pressure on companies to adopt or develop sustainability standards[12].

Wholesale, processing, retail and food service. Certified farmers typically sell directly to exporters or other large companies, such as manufacturers, retail or restaurant chains in high-income countries, which might also support—and require—farmers to adopt and comply with standards[5,6]. Traders, processors and manufacturers must segment their supply chains—separating certified and non-certified products—to preserve the premium arising from certification. This implies higher costs for post-farmgate supply chain actors, even where the standard does not specify requirements post-farmgate.

Promoting sustainability goals along supply chains is an important corporate social responsibility strategy. Large manufacturers (for example, Mars and Ferrero), as well as retailers (for example, Whole Foods Market) and food service providers (for example, Starbucks), have publicly committed to increasing the share of certified raw materials in their products[7,45]. Companies might adopt NGO standards, participate in multi-stakeholder initiatives or develop their own, often weaker standards[5]. A large body of literature examines companies' motives to adopt, develop and promote standards[33]. Among these are that standards help to increase quality control, reduce risks, avoid brand reputation damage[45] and attract customers[46], all with the aim of boosting profits over time[6,8,33]. By signalling awareness and action, companies can ensure not only consumer but also policymaker support[46]. A key motivation for companies to develop their own standards is to maintain control over price premiums[47].

Consumers. Global market shares of sustainability-certified products, although increasing, remain small, except for in a handful of high-income countries with large certified markets. For example, organic retail sales are 10–12% of food retail in Denmark and Switzerland (Fig. 1d), and Fairtrade sales are around 1% in Switzerland, Sweden and Finland. For specific products, certified market shares can be much larger, such as for UTZ-certified cocoa or 4C-certified coffee. For the vast majority of global consumers, however, factors such as price, product appearance, nutritional value, safety and taste rather than sustainability standards (for example, fairness or environmental impact) determine everyday shopping decisions[20,48,49]. The complexity of social and environmental problems in global food production and numerous standards with similar claims contribute to consumer confusion and limited demand[35,47,50].

Most sustainability criteria are credence attributes (that is, they are unverifiable by consumers, even after purchase and consumption). This raises the importance of standard-setting bodies—and other actors—that develop and maintain a system to ensure traceability and create and sustain consumer trust (that is, internal and external audits and separate handling of certified and non-certified products post-farmgate). Product labels communicate to consumers that standards were met. Yet, ultimately, the system relies on trust and signalling. Hence, marketing and branding play a crucial role[9].

Economic, social and environmental effects of standards

Farmers and farmer organizations. On average, the estimated economic effects of certification on farmers seem moderately positive[11,16,17]. Many studies analyse the implications of sustainability standards for farmers, with a focus on Fairtrade and organic coffee certification in Latin America and sub-Saharan Africa. Results are mixed. For example, organic–Fairtrade double certification of coffee farmers in Uganda increases producer prices but reduces land and labour productivity, and thus does not affect net incomes[51]. Other studies suggest that organic certification increases revenues among cocoa farmers in Uganda[41]. Variable findings might result from intrinsic heterogeneity, as standards involve a wide array of detailed rules, recommendations and services that may differentially affect farmers' yields, prices, costs, profits and household incomes[11]. For instance, while training might increase the quality and quantity of output, required pesticide restrictions might increase labour costs. Several empirical reviews highlight that implementation costs and overall outcomes can vary across standards, crops, regions and other contextual and farmer-specific characteristics[11,16,17].

Empirical results on social outcomes (such as health and education) are more consistently positive across studies[24,52,53]. For example, GlobalGAP and Fairtrade were found to contribute to safer use of agrochemicals in Kenya[52] and Côte d'Ivoire[54]. Social effects are often more indirect and linked to the certification-induced expansion of services that farmer organizations offer to their members[43,55].

Workers and communities. A few studies, mainly on the horticultural export sector in Africa and Latin America, suggest that workers employed by certified companies earn higher wages, are employed longer and have better access to social services than those working for non-certified companies[56–59]. Various qualitative studies support these findings, but question whether standards sufficiently challenge power hierarchies and achieve decent (rather than just better) working conditions[29,37,38,60]. A few studies focus on workers employed by small farms and suggest that these workers do not benefit from certification of their employers[43,61,62]. In the small-farm sector, working conditions are difficult to monitor. Furthermore, standards often do not account for diverse working and sharecropping arrangements. Without precise rules and close monitoring, small-scale farmers, often poor themselves, have little incentive to pay higher wages and improve the social conditions of their workers[43].

Standards may also affect community members who do not participate in certification directly. Certified farmer organizations or companies might build roads and schools and offer health care and improved access to information (for example, on farm practices). Standards could also affect prices and quality requirements in local, non-certified markets[63].

Export performance and trade. Several studies examine whether the adoption of sustainability standards—and standards more generally—improves companies' and countries' export performance. While some studies show that standards can act as barriers to trade[64], others find no effect[65], or suggest that standards improve export performance and access to higher-value markets[66]. Compliance costs and benefits differ between standards, sectors and types of actors involved[3]. Given the large heterogeneity of standards, actors and conditions, no generalizable conclusions exist regarding the direction and magnitude of (aggregate) effects.

Manufacturing, retail and food service. A large body of literature examines how standards influence power relations within value chains. A key finding is that large companies—especially processors, restaurant chains, supermarkets and third-party logistics service providers—have gained substantial power from market consolidation over the last few decades[6,34,35,67,68]. Many companies have established or influenced standards to serve their strategic commercial interests. This often leads to accusations of greenwashing (that is, a company making deceptive environmental or social claims about its products). Retailers and restaurant chains have perhaps disproportionately gained power (for example, can define entry requirements, quality standards, prices and the timing of delivery), leading to buyer-driven supply chains[12,46]. As power shifts to consumer-facing multinational firms, standard-setting organizations such as Fairtrade increasingly struggle to pursue their original objectives to challenge consolidated market structures[13].

The finding that companies hold substantial power in global value chains is not unique to certified value chains. The greatest share of the retail price paid by consumers for tropical export crops such as coffee and cocoa goes to manufacturers (for example, roasters) and retailers, not to farmers[35]. Yet case studies from Finland[69] and the United States[70] suggest that the share of the retail price transmitted back to farmers might actually be smaller for certified than for non-certified products. This could indicate that retailers and manufacturers reap a disproportionate share of the marginal revenue from certification. Farmers' net income might nonetheless increase, even if the share of the consumer price is smaller, as certified products are typically more expensive.

Environment. The adoption of sustainability standards is typically found to increase the use of farming practices that promote soil fertility, water conservation and biodiversity (such as the use of compost, hedges, crop rotation or intercropping) while reducing the use of environmentally harmful practices (such as overuse of agrochemical inputs)[71–73]. For instance, organic certification increases the use of organic fertilizers and reduces sewage disposal in the field among coffee farmers in Colombia[73]. Agrochemicals are banned under organic standards, so lower use of agrochemicals is expected, unless non-certified farmers are organic by default. Other sustainability standards' effects on the use of agrochemicals are less straightforward and probably depend on the degree to which such inputs are provided or promoted by farmer organizations[54]. Although standards promote and require or ban certain farm practices, outcomes are typically not monitored by auditors[25].

Few research studies go beyond the analysis of farming practices to evaluate actual environmental outcomes of sustainability certification, such as effects on biodiversity[74,75], carbon storage[76], fire incidence[75] or deforestation[25,77–79]. The limited available evidence is not conclusive. Moreover, with few exceptions[80,81], most studies focus on the plot or farm level and, thus, do not capture possible environmental spillovers and landscape-wide effects. Research that evaluates environmental effects of certification per unit of output rather than per unit of land can capture some spillovers[22,23], but not necessarily all. For instance, sustainability standards may incentivize consumers to buy more of a certified product, given its lower per unit environmental effect, potentially leading to a larger overall environmental impact[82].

Emerging issues and future research

The findings in the extant literature leave several key questions unanswered. We consider these priorities for future research on the role and impacts of sustainability standards in global agrifood supply chains.

Does the literature capture causal effects of standards? Can we be sure that observed differences between certified and non-certified farms, companies, and communities are caused by sustainability standards—or could such differences be attributable to pre-existing differences that induce differential selection into voluntary participation in certification schemes, generating a misleading correlation?

Certification—especially in the small-farm sector—involves actors at different levels. Non-random self-selection is a potential concern at all levels. First, suppose a development agency decides to implement a programme aimed at helping certify farmers. The decision regarding which region to target is unlikely to be random but instead influenced by factors such as physical accessibility, safety and agricultural potential[83]. While development agencies want to target poor regions and farmers, targeting the most marginalized (for example, conflict-affected) regions is probably infeasible for most certification support programmes. The situation is similar for company-operated contract schemes, although companies have fewer incentives to target poor regions—and might thus focus on better-off locations to reduce costs[68,83,84].

Second, participation in certification schemes by farmer organizations is also not random. Development agencies might prefer working with farmer organizations that already have some organizational capacity, increasing the likelihood of sustained certification. Similarly, well-functioning organizations that already offer certain member services might be more willing to participate[13,35].

Third, most standards allow farmer organizations to certify only part of their total production, thus leaving room for organizations to involve only members who can easily meet standards due to skill or scale, or that already met the standards before certification[42]. Also, farmers who already comply with most criteria might be particularly keen to participate.

Fourth, farmers can often certify only part of their total production[85] and can thus choose only those plots on which standards are most easily achieved. Finally, farmer organizations, companies and farmers purposefully select their workers[43].

In sum, certification might act as a means of distinguishing different kinds of locations, organizations, farmers and workers who participate in the existing marketplace rather than improving or changing their circumstances on average. The complexity of non-random selection poses serious empirical challenges for rigorous causal identification of the impacts of certification. Most available studies on smallholder certification use cross-sectional observational data, limiting the options to deal with selection bias. Randomized experimental data, before–after comparisons and panel data would increase options to deal with selection bias at the farmer level. Additionally, to address selection issues downstream among farmer organizations for example, future research could incorporate insights from value chain research, which highlights the importance of institutions and the organization of supply chains for certification outcomes[6,55]. This would require adopting sampling strategies that involve a larger number of farmer organizations and buyers. Currently, with only a few exceptions[43,55], most studies are based on data from a relatively large number of farmers—but a small number of farmer organizations in a purposefully selected location[55]. Such purposeful sampling designs not only reduce options to deal with selection issues, but they also limit the external validity of results beyond the concrete cases. The use of more population and/or landscape representative data would improve external validity, but increases the cost and complexity of primary research.

More generally, we propose that future studies on sustainability standards should examine implications for actors other than smallholder farmers. More rigorous impact analyses are needed to better understand implications for different types of workers, host communities, actors in non-certified supply chains and post-farmgate actors (for example, traders, processors and retailers). For example, we are not aware of any study that calculates direct and indirect costs and revenues associated with certification accruing at different levels of the supply chain. Given that multiple actors promote and

finance certification, it is difficult to know who bears the financial burden or reaps the rewards[4]. It would be especially interesting to know how much funding development agencies have been investing in certification-related projects and what the return on investment has been in terms of environmental or social outcomes.

Irrespective of the type of actors studied, the body of literature on the impacts of standards is overwhelmingly empirical. Given mixed results and unclear drivers of impact heterogeneity, we also anticipate substantial value added from enhanced incorporation (or development) of theory in agrifood supply chain studies[3].

Are poor farmers excluded? A concern closely related to selection issues is whether the poorest farmers, regions and countries might be excluded from sustainability standards, due to either high entry barriers[6,9] or strategic placement decisions of companies and agencies[83,84]. In contrast to the common narrative of exclusion, many empirical studies suggest that resource-poor farmers actively participate in certified supply chains. As discussed, this may be attributable to group certification approaches and external support. Yet being resource poor is relative. While a large share of the world's certified farms operate in developing countries (see above), these are mostly found in middle-income, not low-income, countries[86], emphasizing that the proliferation of standards seems difficult without a certain level of infrastructure, markets and institutions[5]. This suggests that the most marginalized farmers, regions and countries are more likely to be excluded from certified and higher-value supply chains than the better off[83]. Future research could examine the geographical distribution of participation and returns, and related barriers and opportunities in more detail, to probe these questions of systematic exclusion at greater depth and rigour.

How to ensure enforcement and compliance? The enforcement of rules and contracts and the punishment of non-compliance are generally difficult when working with a large number of spatially dispersed farmers. Building on the prior point, the only feasible punishment may be exclusion from the programme. Sustainability standards involve specific rules, many of which are inherently difficult to measure and monitor (for example, sensitive issues such as child labour). As compliance can be difficult and costly, incentives exist to find loopholes or to cheat[87]. However, due to a combination of external audits and internal control systems, farms, organizations and companies that fail to meet standards in several important ways are unlikely to be certified at all or over a longer period.

Companies operating contract and certification schemes typically hire extension workers to ensure farmers comply with standards. Farmer organizations also implement internal control systems that generally rely on group pressure, monitoring by peers and internal inspectors, and detailed documentation at the farmer organization level. Internal inspectors may, however, be influenced by their social ties and are not necessarily neutral observers[39], but they and their organizations face incentives to pass external inspections and thus increase their groups' compliance. If too many members fail to comply, participation of the entire organization might be at risk. Thus, there are noticeable parallels between internal auditing in group certification and group micro-lending[88,89]. Both are similarly vulnerable to individual and group defection, with trade-offs between widespread participation and near-universal compliance.

The certified unit (for example, company or farmer organization) hires the external inspectors[39], and incentives exist to choose less stringent inspectors. Inspectors, in turn, face incentives to let clients pass, so that they are hired again[90]. Relatedly, external audits are often announced in advance and can thus be prepared for. During external audits of farmer organizations, certification inspectors visit farmer organizations' facilities, review the organizations' documentation and visit (a small number of) individual farmers. Given the often-large number of members of farmer organizations, on-site monitoring of all participating farms by certification inspectors is prohibitively expensive. Thus, many farmers are never subject to inspections, which might reduce compliance levels[91]. For example, up to 50% and 79% of certified Ghanaian cocoa farmers were never inspected by internal auditors and external auditors, respectively[39]. Fraud can also occur downstream in the supply chain. Purposeful mislabelling by suppliers[92] is one example with particularly detrimental effects on consumer trust.

So are there practices, rules or technologies that increase compliance with standards in a cost-effective manner? Emergent digital technology might provide suitable approaches to reducing the costs of monitoring. Moreover, given the considerable costs of monitoring, especially in the smallholder sector, assessing the costs and effectiveness of different group certification and monitoring approaches is an interesting direction for future research. Insights from behavioural economics and the use of experimental research methods could be particularly fruitful here, as different approaches to auditing, peer control and punishment could be modified and randomized to establish a clear causal mechanism from enforcement practices to standards compliance.

How are price premiums maintained? The supply of certified products has increased sharply over time. However, demand for certified products remains limited, as premium price levels for certified products exceed willingness to pay among most global consumers, and that seems unlikely to change soon (see below). Thus, a large share of the certified production volume (30–70%, with large variation across standards, crops and years) is actually not sold as certified by farmers[7,13,42,93]. Some transitory oversupply is to be expected due to seasonal and stochastic variation in supply and demand addressed through inter-seasonal storage and intermarket arbitrage. Nonetheless, the data on the share of certified products not ultimately sold through certified supply chains seem higher than what usual models of oversupply would predict. The persistence of both excess supply of certified products and price premiums on those products merits more rigorous investigation.

Excess supply might be expected for standards such as Fairtrade that rely on a floor price mechanism without regulating quantities[93]. The (transitory) premium creates incentives for farmers to enter the market, leading to excess supply and eventually driving the marginal benefits for participating farmers to zero[93]. This nonetheless does not explain the observed patterns. Over the last 10 years, the Fairtrade floor prices for coffee and cocoa very rarely bound, meaning that the observed prices were higher than the floor prices in most years. Moreover, excess supply is observed not only for Fairtrade (the only standard with a floor price) but for all standards. For standards that do not regulate quantities or price, market price adjustments should ensure that supply does not exceed demand on average. Hence, other reasons are probably relevant for explaining oversupply.

Oversupply does not mean that farmers do not benefit economically, as long as profits from certified sales cover certification-related costs. It can make economic sense for farmer organizations to produce larger quantities of certified products than they expect to sell (for example, because the exclusion of individual members is socially infeasible). Relatedly, once infrastructure and expertise to operate certification schemes are in place, the marginal cost of certifying additional members or adopting additional standards can become relatively inexpensive.

As already discussed, certified farmer organizations are more often than not supported by external actors. Such support acts as a subsidy[94] and reduces entry barriers and compliance costs, thus making certification profitable for a larger number of farmers and farmer organizations. Some oversupply may be attributable to external subsidies, although no hard evidence exists to test this claim.

Why have price premiums not diminished more substantially over the past decade?[11] From a business perspective, artificially limiting quantities and keeping consumer (and farmer) prices relatively high might be useful, especially considering products that consumers expect to be more expensive. Export markets such as the coffee and cocoa sector are highly concentrated, with a small number of companies with substantial market power. The same holds for the retail sector in many importing countries. Thus, distortions due to market power may help explain the existence of price premiums despite oversupply. More research on the causes and effects of oversupply would be highly policy relevant, especially in light of persistent subsidization of certification. Here too, theory would be useful to inform empirical research.

One final candidate hypothesis to explain oversupply is that supply chain segmentation (that is, separate handling of certified and non-certified products) plays a role, as illustrated by maize and soybeans in Brazil[95]. Segmentation increases the likelihood of oversupply. Infrastructure investments, switching from multi-modal to unimodal logistics—because inter-modal connections are often the most inefficient and costly in segmented chains—and digitization to reduce monitoring costs may allow economies of scale and scope, reducing segmentation and node-specific oversupply. This possibility remains seriously understudied, however, and whether the resulting supply chain cost savings pass through to consumers and/or reduce producer price premiums remains unclear and probably will vary over products and countries.

Should we expect continued proliferation of standards? The proliferation of standards has followed demand expansion, especially among high-income consumers willing to pay a premium for credence attributes. Yet the vast majority of food demand growth over the coming three decades will come from low- and middle-income countries[96]. What implications does this have for sustainability standards in future agrifood supply chains?

Currently, sustainability standards are primarily relevant for a handful of products, including coffee and cocoa (see Fig. 1)[97]. Notably, these are products where consumption is concentrated in higher-income and production in lower-income countries[98]. As consumption of agrifood commodities—including products increasingly subject to certification, such as palm oil—shifts to emerging economies, these patterns will probably drive future trends in the proliferation of sustainability standards. Is consumer demand for sustainability-related credence attributes in emerging countries as income and price elastic as that of consumers in high-income countries?[98] A recent study of certified palm oil in China and India finds that the market for certified products remains limited[98]. Palm oil is considered a cheap cooking oil in India, consumed mainly by poor consumers and retailed by many small shops, few of them interested in certified oil. In China, it is mainly an ingredient in processed foods, resulting in a much larger certified oil market than in India, which seems due to: the much bigger role of large multinational and domestic companies accustomed to certification from their engagement in global markets and actively promoting certified products in China more than in India; the government's campaign for a green economy; foreign NGOs promoting certification in China's market. This reinforces our earlier points that sustainability standards and markets are increasingly driven by private companies and that future research would ideally focus on supply chain actors beyond just farmers and consumers. This study suggests that as emerging country food economies increasingly integrate with world markets, the demand for certified products may grow as it did in the developed countries despite present low demand. However, this remains an underexplored question. How slow or fast such changes occur and whether they are driven by consumer and macroeconomic behaviour or by global firms remains unclear.

Conclusions

Sustainability standards have gained in importance in global agrifood supply chains, as diverse actors have been involved in their design, promotion, implementation and commercialization. In this mainstreaming process, large international companies have gained power[12,46], and this development will probably continue with the penetration of emerging country markets[98]. This development makes it more difficult for NGO-driven standards to deliver on their original objectives to challenge prevalent market structures and inequalities. Relatedly, small-scale farmers' interests and voices are rarely included when standards are defined[32]. Standards tend to be dominated by Western experts' ideas[33], often reflecting business interests and those of wealthy consumers[34].

Certification involves extra costs for all supply chain actors[44,69,70,99]. Those costs are covered by some combination of the price premium paid by consumers of certified products, taxpayers in countries that subsidize certification and third-party organizations and their supporters (for example, NGOs). Given the diverse actors involved, it becomes increasingly difficult to determine who bears what share of the economic burden, and who captures the economic, environmental or social benefits.

Participants with little bargaining power (for example, farmers and workers, especially those in the coffee and cocoa sectors that are highly concentrated downstream) are unlikely to reap a substantial share of the price benefit. Thus, the common narrative—that the price premium paid by consumers is a cash transfer or donation to farmers—is typically misleading. However, participating farmers are typically found to gain from participation, although benefits might not always be captured by short-term, purely economic outcomes[24,53].

Supply has grown faster than demand for many certified crops. Oversupply can make economic sense for farmers—as long as benefits from certified sales exceed certification-related costs. External support from development agencies often acts as a subsidy that reduces entry barriers and costs facing farmers, thus also contributing to oversupply. It is not clear whether smallholder certification would be either possible or increasing at observed rates without such external support. However, the gap between supply and demand might tighten in the future, as more multinational companies announce commitments to source large quantities of their raw material from sustainably certified production. Much will turn on consumer and firm behaviour in emerging countries where future food demand growth will be heavily concentrated.

A common and pertinent concern is that farmers and other supply chain actors that already largely complied with standards before certification self-select into certified supply chains, so that certification would have little additional effect. The increasing number of different standards with similar yet varying criteria may exacerbate this tendency, allowing companies, farmers and other actors to select standards that require little actual change[85]. Additionally, the stringency of standards is not necessarily positively correlated with the price premium[47], further increasing incentives to adopt less stringent standards. Consequently, participation rates can be expected to remain low for particularly stringent standards and in sectors where exploitation and environmentally harmful practices are prevalent. Increasing adoption rates among those who face high compliance costs increases challenges to ensure and monitor compliance. When compliance costs are high, there exist greater incentives to cheat or to find loopholes in the rules[87]. Thus, sustainability standards face some of the same challenges as other voluntary/sustainability initiatives, namely a trade-off between high adoption rates and compliance[4].

While sustainability standards have transformed the coffee and cocoa sectors, they remain of only marginal importance in most other agrifood sectors. Thus, globally, standards currently affect only a small number of consumers and farmers, and relatively

little agricultural land, even when considering possible spillover effects. Therefore, the potential of standards to transform entire food systems remains limited. Making global food systems more sustainable will require governmental action[46] beyond specific sectors, including improvements in infrastructure and social services in poor countries as well as fair trade conditions and social and environmental regulations from the local to the global level. The most important contribution of sustainability standards may be the potential to influence the debate[4] and draw public attention to social and environmental injustices along global agrifood supply chains.

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E.-M.M., C.B.B., H.C.M., M.Q., T.R. and J.S. developed the research idea. E.-M.M. drafted the paper. All other authors commented on and contributed to writing the final version of the paper.

Competing interests

The authors declare no competing interests.

Additional information

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